PCEC in ACE

The Power of Third Parties

2014 NASA Cost Symposium
LaRC, August 12th, 2014

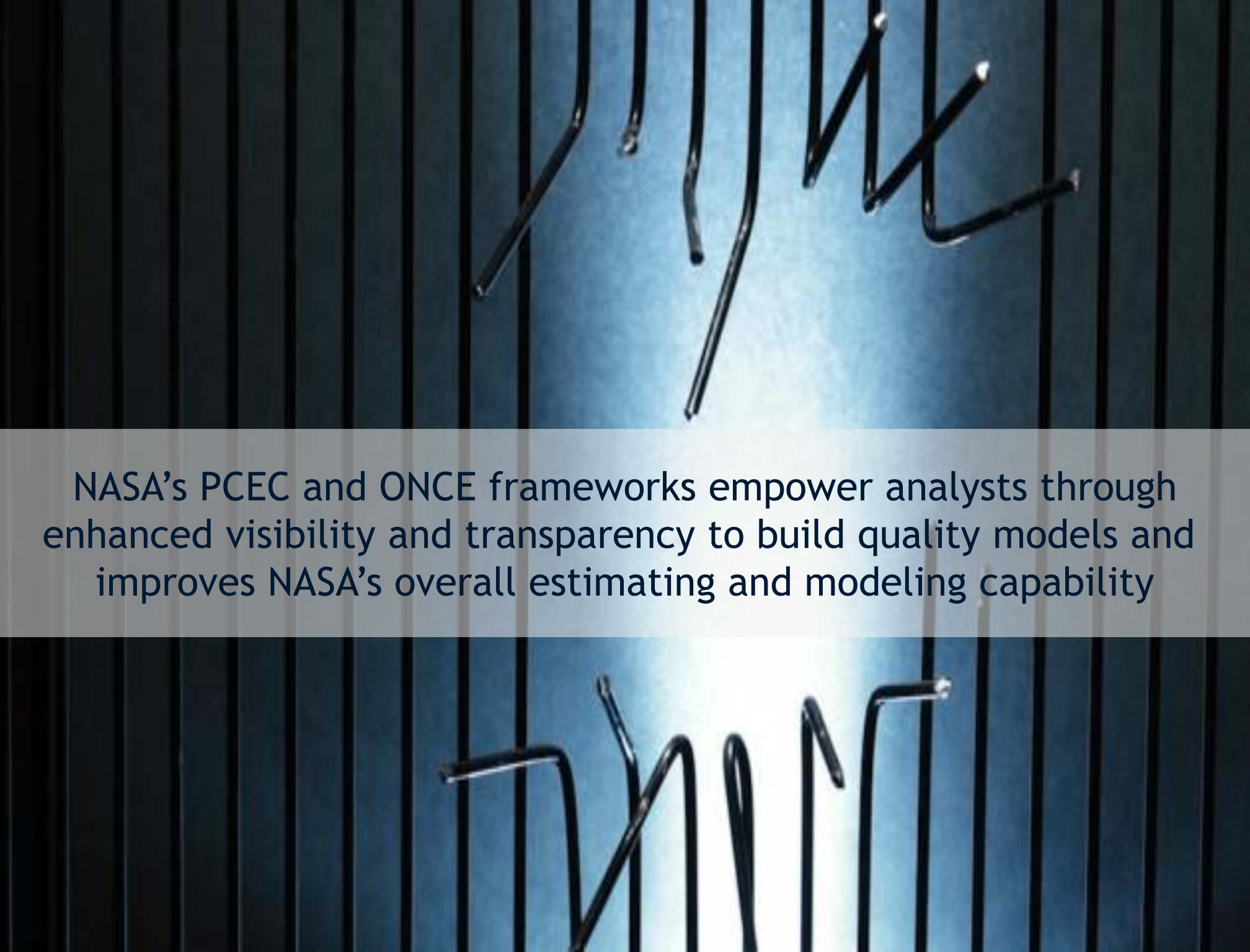
Presenter: Antonio Rippe – Tecolote Research

Abstract

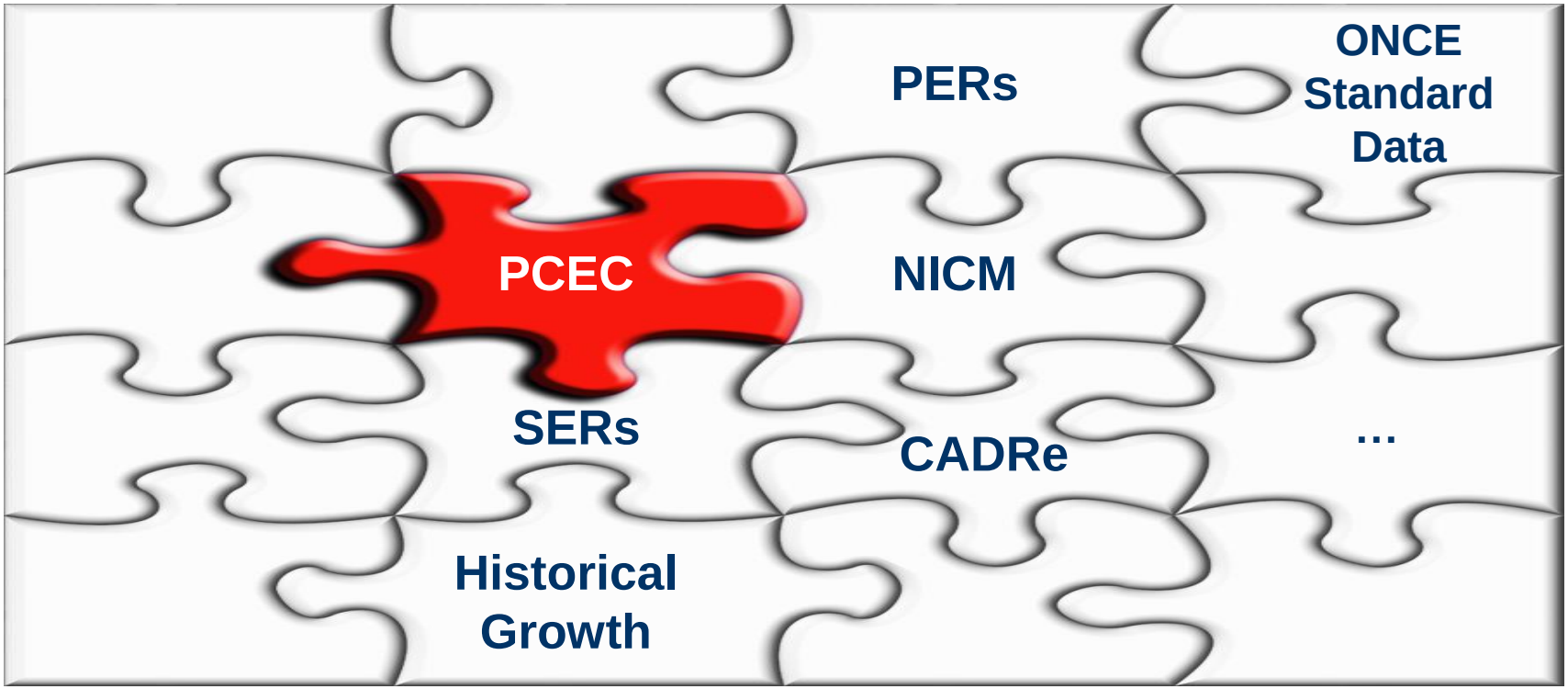
In 2014, NASA released the Project Cost Estimating Capability (PCEC). This is the continuation of data collection, methodology development, and model development activities that were formerly contained within NAFCOM. PCEC contains an accessible library of NASA cost estimating relationships (CERs) to enable analysts the flexibility to use or modify equations as needed for their analysis.

ACEIT is a Government funded application that is standard within the Army, DHS, Navy, and Air Force organizations. ACEIT consists of a suite of analyst applications ranging from a statistics application (CO$TAT) to a time-phased data integration and simulation engine (ACE) to an integrated cost/schedule risk tool (JACS) that can be used for JCL analysis. The ACE application is robust and fully allows users to build their own models, incorporate phasing, and apply uncertainty to develop risk-based and time-phased cost estimates. In addition, ACE allows the user to assess/develop multiple scenarios on changes of input parameters or equations and to view the results in powerful Excel reports through the use of an Excel add-in (POST).

This paper demonstrates the ability for ACE to capture the equations contained in PCEC and develop estimates. In addition, the power of ACE allows for time-phasing of costs and for the incorporation of risk analysis based on simulation modeling. ACE's capability allows uncertainty on input parameters (e.g., mass) as well as to describe the error in the underlying cost equation. This paper will showcase the ease in which a PCEC based cost estimate can be run in ACE.



NASA’s PCEC and ONCE frameworks empower analysts through enhanced visibility and transparency to build quality models and improves NASA’s overall estimating and modeling capability



ONCE is repository for quality information for analysts

Analysts can use the information to build custom models

- PCEC equations
- NICM Results
- Analogies
- Schedule Estimating Relationships
- Phasing Relationships
- Mass Growth

Robust API

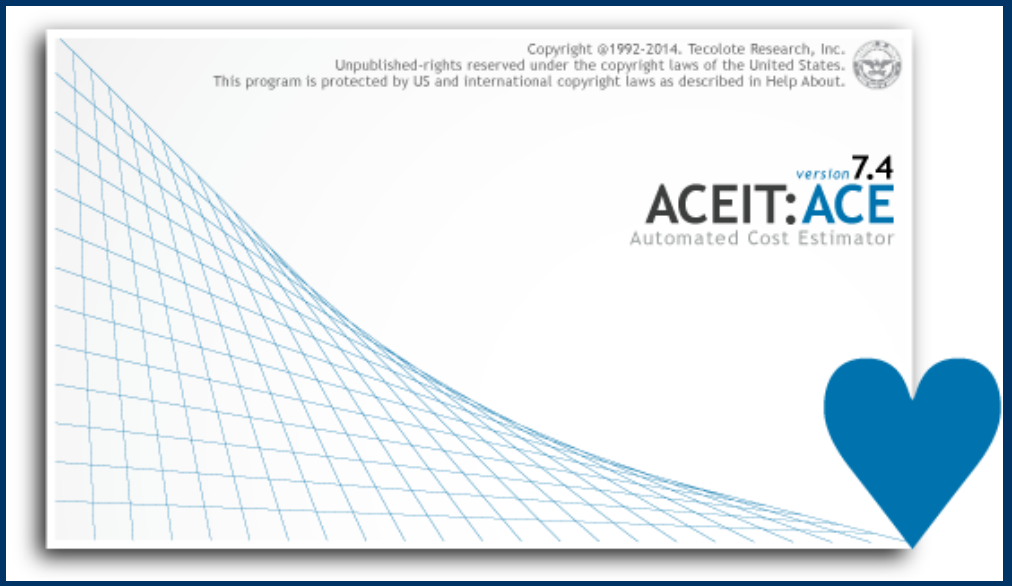
Learning Curve

Time Phasing

Schedule Risk Analysis

Date calculations

Interactive Charts



Documentation

Excel Integration

Automated Error Checking

Distribution specification

Unlimited What-If's

Joint Confidence Level

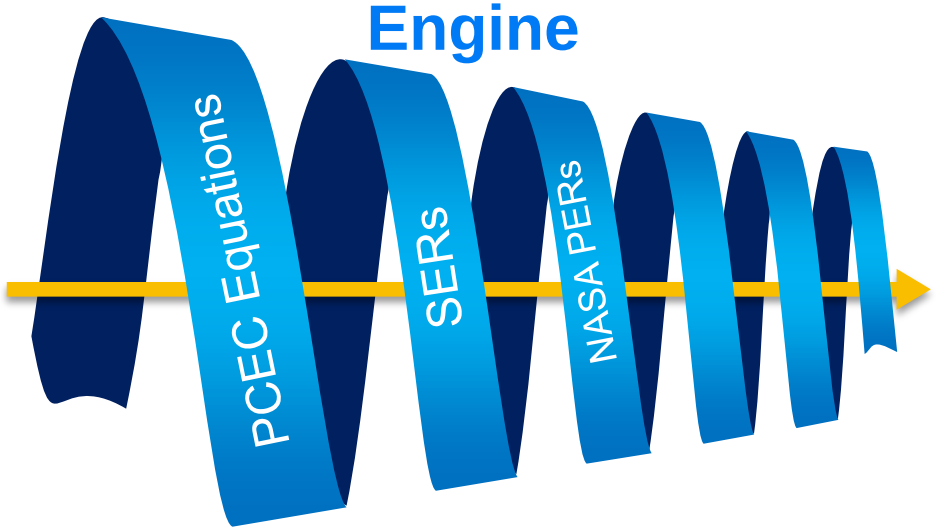
Simulation

Tabular reports

Inputs

- System Parameters
- Subsystem Mass & Technical
- Schedule & Phasing
- Instrument Costs
- Risk/Uncertainty Inputs

ACE Calculation Engine



Outputs

- Phased Results
- Risk S-Curves
- Graphical / Tabular Result Capability

ACE exists in a “stand-alone” state which can be used by analysis familiar with the platform.

The excel interface simply deliverers the parameters needed for ACE to complete the calculations and provide the data for Graphical and/or Tabular result generation.

- Excel
- ACE
- POST

Global Inputs

PCEC INPUTS

Global Variables	
Multivariable Type	(1) Other
System Test Hardware Quantity	1
Flight Unit Percent	130
Start Year	2013
Flight Year	2020
Design Life (# of months)	70

Weight Table	
Total Spacecraft	**361.6**
Structures & Mechanisms	226.1
Thermal Control	11.4
Reaction Control Subsystem	0
Electrical Power and Distribution	69.9
Command, Control & Data Handling	41.4
Attitude Determination & Control	12.8
Apogee Kick Motor	0

Wrap Values	
Fee Percent	0.1
Program Support Percent	0.15
Contingency Percent	0.05
Vehicle Level Integration Percent	0.1

System Integration			
	Hardware Class	Orbit	Spacecraft Class
N	Crewed	Crewed	Crewed
N	Crewed	Earth Orbiting	Observatory
N	Engine	Engine	Engine
N	LV	LV	Liquid Stage
N	LV	LV	Solid Stage
Y	Uncrewed	Earth Orbiting	Communication
Y	Uncrewed	Earth Orbiting	Mapping/Meteorological
Y	Uncrewed	Earth Orbiting	Observatory
Y	Uncrewed	Earth Orbiting	Positioning
Y	Uncrewed	Earth Orbiting	Reconnaissance
Y	Uncrewed	Earth Orbiting	Scientific
N	Uncrewed	Planetary	Inner Planet Explorer
N	Uncrewed	Planetary	Lander
N	Uncrewed	Planetary	Outer Planet Explorer
N	Uncrewed	Planetary	Probe

SCHEDULE ESTIMATE INPUTS

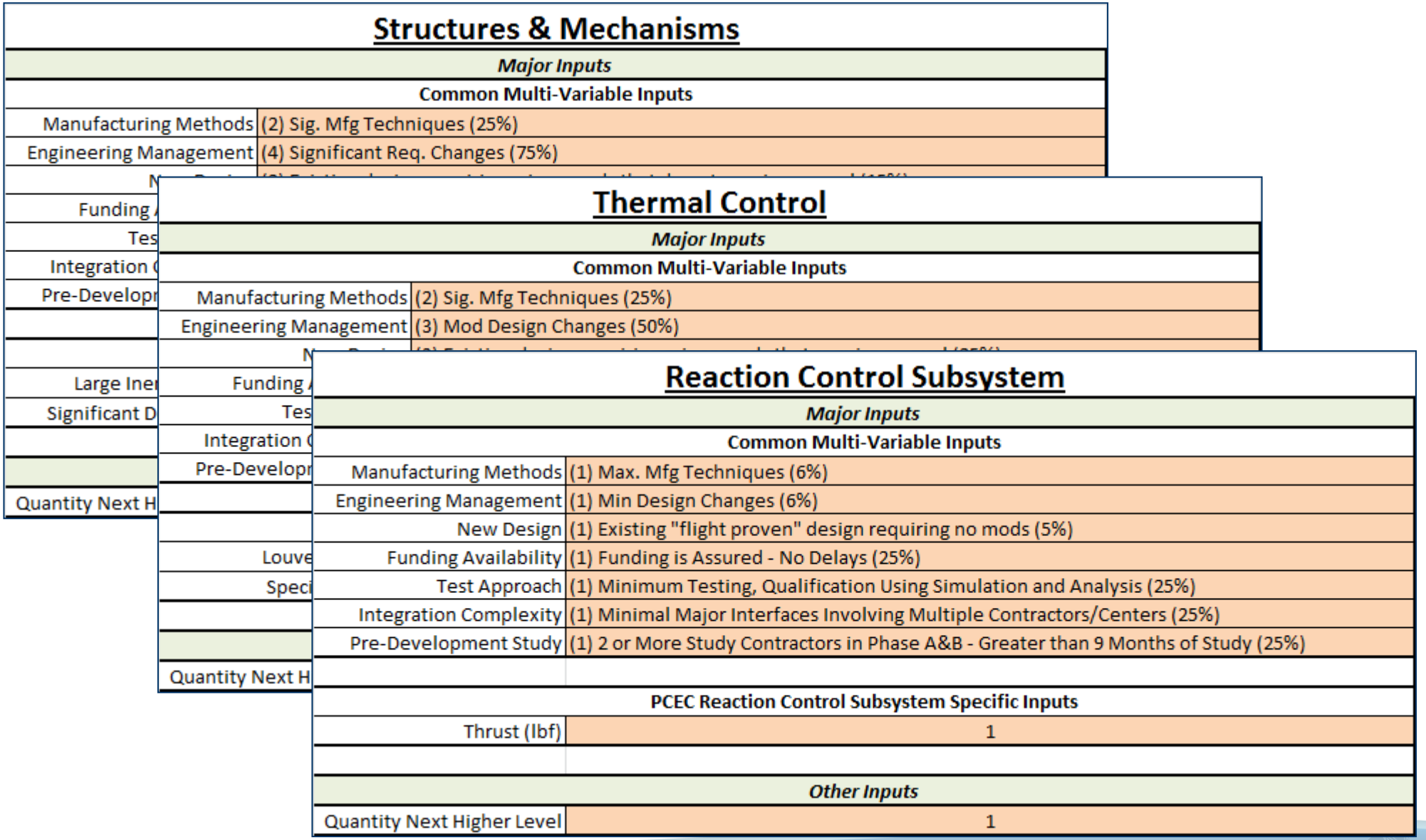
Select SER method:	QuickCost

Please enter Phase A duration (months)	10

QUICKCOST INPUTS	
Destination	Earth Orbiting
Instrument Complexity	0.5
Desired Confidence Level	70%

MCR INPUTS	
Imaginary Intelligence (IMINT) Remote Sensor?	No
Beginning of life (BOL) power in Watts	624
New or Replacement	New
All, Planetary, or Nonplanetary?	All

Subsystem Inputs



Structures & Mechanisms

Major Inputs	
Common Multi-Variable Inputs	
Manufacturing Methods	(2) Sig. Mfg Techniques (25%)
Engineering Management	(4) Significant Req. Changes (75%)

Thermal Control

Major Inputs	
Common Multi-Variable Inputs	
Manufacturing Methods	(2) Sig. Mfg Techniques (25%)
Engineering Management	(3) Mod Design Changes (50%)

Reaction Control Subsystem

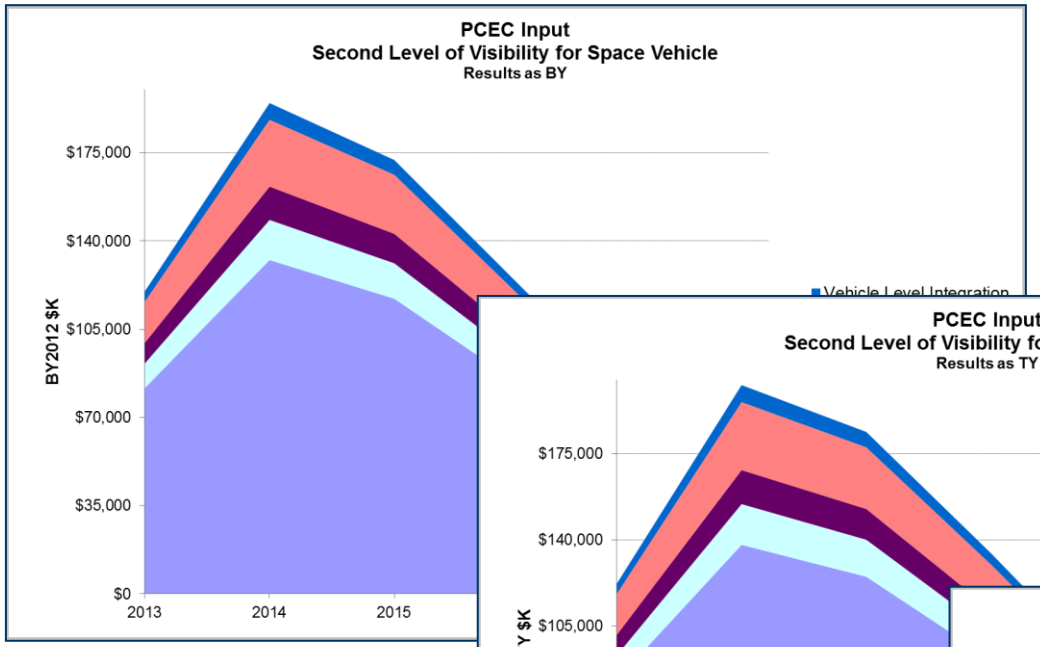
Major Inputs	
Common Multi-Variable Inputs	
Manufacturing Methods	(1) Max. Mfg Techniques (6%)
Engineering Management	(1) Min Design Changes (6%)
New Design	(1) Existing "flight proven" design requiring no mods (5%)
Funding Availability	(1) Funding is Assured - No Delays (25%)
Test Approach	(1) Minimum Testing, Qualification Using Simulation and Analysis (25%)
Integration Complexity	(1) Minimal Major Interfaces Involving Multiple Contractors/Centers (25%)
Pre-Development Study	(1) 2 or More Study Contractors in Phase A&B - Greater than 9 Months of Study (25%)
PCEC Reaction Control Subsystem Specific Inputs	
Thrust (lbf)	1
Other Inputs	
Quantity Next Higher Level	1

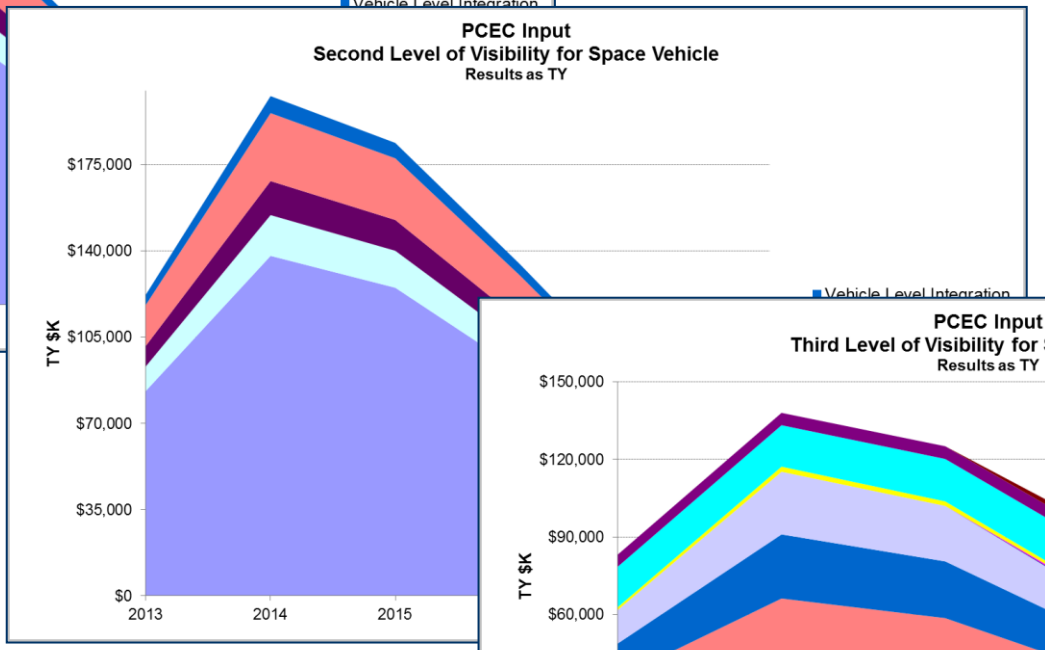
Cost Estimate Results

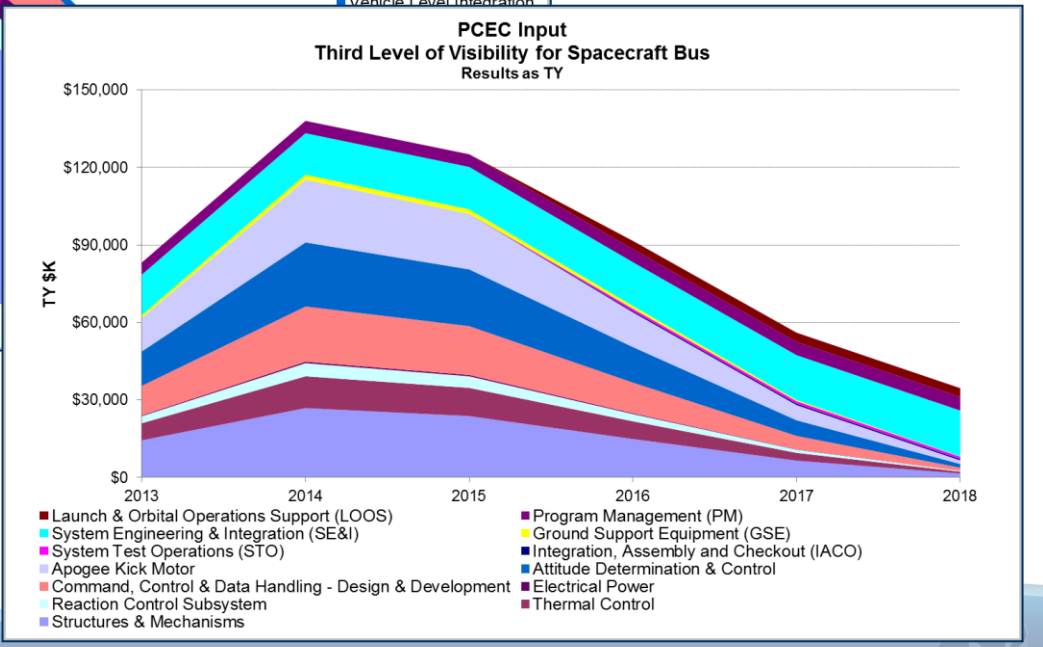
FY12$K					
WBS Element	**DDT&E**	**D&D**	**STH**	**Flt Unit**	**Total**
Spacecraft Bus	**$ 573,310.75**	**$ 159,774.11**	**$ 110,689.66**	**$ 153,366.80**	**$ 726,677.55**
Spacecraft Bus Subsystems	**$ 270,463.77**	**$ 159,774.11**	**$ 110,689.66**	**$ 85,145.89**	**$ 355,609.66**
Structures & Mechanisms	$ 64,854.66	$ 41,389.95	$ 23,464.71	$ 18,049.78	**$ 82,904.44**
Thermal Control	$ 27,625.82	$ 14,147.94	$ 13,477.88	$ 10,367.60	**$ 37,993.42**
Reaction Control Subsystem	$ 12,045.22	$ 7,352.70	$ 4,692.52	$ 3,609.63	**$ 15,654.85**
Electrical Power and Distribution	$ 1,062.71	$ 149.97	$ 912.73	$ 702.10	**$ 1,764.81**
Command, Control & Data Handling	$ 54,223.63	$ 38,982.58	$ 15,241.05	$ 11,723.88	**$ 65,947.51**
Attitude Determination & Control	$ 59,252.82	$ 36,809.84	$ 22,442.98	$ 17,263.83	**$ 76,516.65**
Apogee Kick Motor	$ 51,398.91	$ 20,941.13	$ 30,457.78	$ 23,429.06	**$ 74,827.98**
Spacecraft Bus System Integration	**$ 119,543.54**	$ -	$ -	**$ 19,185.27**	**$ 138,728.81**
Integration, Assembly and Checkout (IACO)	$ -	$ -	$ -	$ 1,332.19	**$ 1,332.19**
System Test Operations (STO)	$ 2,476.73	$ -	$ -		**$ 2,476.73**
Ground Support Equipment (GSE)	$ 6,121.88	$ -	$ -		**$ 6,121.88**
System Engineering & Integration (SE&I)	$ 80,344.89	$ -	$ -	$ 12,014.72	**$ 92,359.61**
Program Management (PM)	$ 21,658.37	$ -	$ -	$ 5,838.36	**$ 27,496.74**
Launch & Orbital Operations Support (LOOS)	$ 8,941.67	$ -	$ -		**$ 8,941.67**
Fee					
Program Support					
Contingency					
Vehicle Level Integration					
Total					

FY14$K					
WBS Element	**DDT&E**	**D&D**	**STH**	**Flt Unit**	**Total**
Spacecraft Bus	**$ 596,784.95**	**$ 166,316.06**	**$ 115,221.84**	**$ 159,646.40**	**$ 756,431.36**
Spacecraft Bus Subsystems	**$ 281,537.91**	**$ 166,316.06**	**$ 115,221.84**	**$ 88,632.19**	**$ 370,170.10**
Structures & Mechanisms	$ 67,510.13	$ 43,084.66	$ 24,425.48	$ 18,788.83	**$ 86,298.96**
Thermal Control	$ 28,756.96	$ 14,727.23	$ 14,029.73	$ 10,792.10	**$ 39,549.06**
Reaction Control Subsystem	$ 12,538.41	$ 7,653.75	$ 4,884.66	$ 3,757.43	**$ 16,295.84**
Electrical Power and Distribution	$ 1,106.22	$ 156.12	$ 950.11	$ 730.85	**$ 1,837.07**
Command, Control & Data Handling	$ 56,443.81	$ 40,578.72	$ 15,865.09	$ 12,203.92	**$ 68,647.73**
Attitude Determination & Control	$ 61,678.93	$ 38,317.02	$ 23,361.90	$ 17,970.70	**$ 79,649.62**
Apogee Kick Motor	$ 53,503.44	$ 21,798.56	$ 31,704.88	$ 24,388.37	**$ 77,891.81**
Spacecraft Bus System Integration	**$ 124,438.25**	$ -	$ -	**$ 19,970.81**	**$ 144,409.06**
Integration, Assembly and Checkout (IACO)	$ -	$ -	$ -	$ 1,386.73	**$ 1,386.73**
System Test Operations (STO)	$ 2,578.14	$ -	$ -	$ -	**$ 2,578.14**
Ground Support Equipment (GSE)	$ 6,372.54	$ -	$ -	$ -	**$ 6,372.54**
System Engineering & Integration (SE&I)	$ 83,634.61	$ -	$ -	$ 12,506.66	**$ 96,141.27**
Program Management (PM)	$ 22,545.18	$ -	$ -	$ 6,077.42	**$ 28,622.59**
Launch & Orbital Operations Support (LOOS)	$ 9,307.78	$ -	$ -	$ -	**$ 9,307.78**
Fee	$ 48,717.14	$ -	$ -	$ 13,032.36	**$ 61,749.50**
Program Support	$ 40,597.62	$ -	$ -	$ 10,860.30	**$ 51,457.92**
Contingency	$ 81,195.23	$ -	$ -	$ 21,720.60	**$ 102,915.83**
Vehicle Level Integration	$ 20,298.81	$ -	$ -	$ 5,430.15	**$ 25,728.96**
Total	**$ 596,784.95**	**$ 166,316.06**	**$ 115,221.84**	**$ 159,646.40**	**$ 756,431.36**

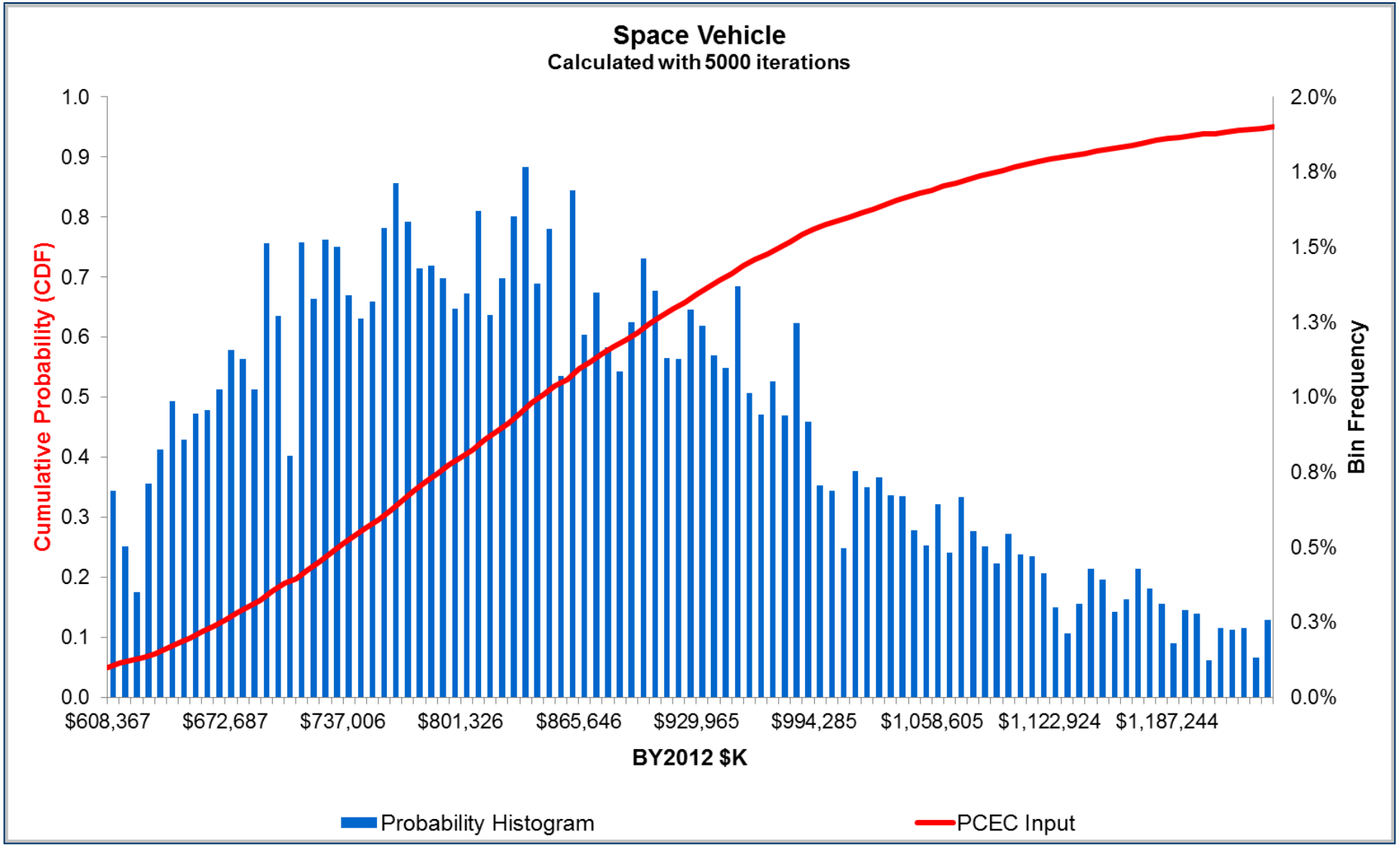
Time-Phased Results







Risk Results



In Conclusion…

PCEC/ACEIT combines the power of several frameworks into a single tool for analysis and reporting

PCEC in ACE Space Vehicle Subsystem model is currently in Beta, but will soon be available to all NASA via CAD

PCEC in ACE results (deterministic and probabilistic) track to PCEC published results

All NASA Organizations have ACEIT licensed

Additional capabilities are being considered for future versions of the PCEC/ACEIT tool – send in feedback

Thank You

For More Information:

Antonio Rippe – arippe@tecolote.com (ACEIT)

Charles Hunt – charles.d.hunt@nasa.gov (CAD East)

James Johnson – james.k.johnson@nasa.gov (CAD West)